



VEYRUM ROBOTICS STANDARD



VRS-IND-102

Industrial — Collaborative-Application Contact Evidence Protocol

The method and apparatus reference for Industrial collaborative-application contact and separation evidence — what documentary evidence must show at the Verified tier and what VRS-IND-110 witnesses at the Certified tier.

VEYRUM RESEARCH INSTITUTE

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Foreword. This Test Protocol is the Industrial sector’s method and apparatus reference for **collaborative-application contact and separation** evidence: it states what contact-force, contact-pressure and separation evidence must demonstrate and against which anchor regimes, and it is the document VRS-IND-110 cites when it witnesses power-and-force-limiting (PFL) contact and protective-separation performance live. It defines no bench test parameters of its own — the anchor standards own the test regimes and the per-region biomechanical **limit values**, and VRS consumes their results. The 2025 revision of **ISO 10218** absorbed the former **ISO/TS 15066** collaborative requirements into the base standard, framing collaboration as a property of the **application**, not the robot, and naming four safeguarding methods: safety-rated monitored stop, hand guiding, speed-and-separation monitoring (SSM), and power-and-force-limiting (PFL) (verified 2026-09-16; Bibliography). In the VRS 2026 edition the sector’s application classes are **mobile · manipulator · legged-other** (VRS-IND-201 §7.3); collaborative applications fall in the **manipulator** class — the earlier **collaborative-application** and **fixed-cell** class names map to **manipulator** once here, and the former **mobile-logistics** class is now **mobile**. Evidence is expressed **by tier**, not by a grade ladder: **documentary** forms (accredited-laboratory force/pressure and separation results, third-party reports and certificates, QMS-witnessed instrumented results) serve the **Verified** rows of the VRS-IND-201 criteria named in Clause 6; **witnessed** forms are the live steps of VRS-IND-110 and serve the **Certified** tier. The body-region taxonomy and the two contact types are fixed by the anchor regime and are therefore **target-independent** (Clause 4.3); which regions an assessed application can reach is a **declared field** recorded per Clause 8 (VRS-GEN-009). A first-of-model assessment is an ordinary assessment under cold-start parity (VRS-GEN-005 §6); an envelope contraction is recorded in the assessment record. No robot holds a Veyrum rating. Requirements use “shall”; recommendations use “should”.

1 1 Scope

This Protocol defines the evidence requirements for the **collaborative-application contact and separation** dimension of Industrial assessments (hazard groups H1/H2, VRS-IND-001 Clause 5) for collaborative applications in the **manipulator** application class (VRS-IND-201 §7.3): what consumed contact-measurement and separation evidence must show (Clause 4), admissible evidence forms by tier (Clause 5), the target-independent safeguarding-method and body-region evidence matrices (Clause 6 and §4.3), a worked example (Clause 7), and consumption and recording (Clause 8). It defines no test apparatus or procedure of its own and does not restate the anchor regime’s biomechanical limit values.

Excluded: detection and safe-stop evidence for the **mobile** and non-collaborative **manipulator** classes (VRS-IND-101); the live witnessing procedure itself (VRS-IND-110); the rating mathematics (VRS-GEN-005/006, VRS-IND-201); and sector applicability and hazard taxonomy (VRS-IND-001).

2 2 Normative references

- **VRS-IND-001**, Industrial Sector Standard; **VRS-IND-201**, Industrial AR Assessment Protocol (the criteria whose Verified rows this evidence serves; application classes §7.3); **VRS-IND-110**,

Industrial Demonstration Protocol (the witnessed steps this evidence feeds); **VRS-IND-101**, Detection and Safe-Stop Evidence Protocol (detection and safe-stop dimension); **VRS-GEN-012**, Evidence and Data Requirements (cited for provenance and consent only); **VRS-GEN-101**, IR category safety_incidents; **VRS-GEN-005**, IR Methodology (§6 cold-start parity); **VRS-GEN-009**, Registry schema (all as dated at assessment).

- Consumed test regimes (the compliance floor VRS rates above – verified 2026-09-16):
 - **ISO 10218-1:2025 / ISO 10218-2:2025** – robotics safety; collaborative-application requirements (PFL, SSM, hand guiding, safety-rated monitored stop), incorporating the absorbed ISO/TS 15066 biomechanical-limit basis and explicit cybersecurity requirements.
 - **ISO/TS 15066:2016** – historic collaborative supplement; original source of the per-body-region quasi-static and transient force/pressure limits (now in ISO 10218-2:2025).
 - **ISO 13855:2024** – positioning of safeguards with respect to the approach of the human body; the minimum-distance / stopping-distance methodology protective-separation evidence is evaluated against (cited, not reproduced – single source, VRS-GEN-002 §7).
 - **ISO 13849-1:2023** – safety-related parts of control systems (SRP/CS); Performance Level PL a–e verification of the safety functions a collaborative application relies on.
 - **IEC 62061:2021** – functional safety of safety-related control systems (SCS); SIL – the alternative control-system-integrity regime a manufacturer may already hold.

3 Terms and definitions

Per VRS-GEN-001 and VRS-IND-001. For this Protocol:

- **Contact evidence** – measured force (N) and pressure (N/cm²) results for intended and incidental contact events, obtained under the anchor regime’s measurement conditions.
- **Separation evidence** – measured results demonstrating speed-and-separation monitoring (SSM) performance: protective separation distance maintained at the declared speeds (m/s).
- **Quasi-static contact** – a clamping or constrained contact where the body region cannot recede from the contact (anchor regime’s clamping-limit basis).
- **Transient contact** – a free, dynamic impact where the body region can recede (anchor regime’s transient-limit basis, typically higher than quasi-static for the same region).
- **Application configuration** – the assessed combination of robot, end-effector, workpiece, payload (kg), speed envelope (m/s), and workspace layout. The tool and workpiece are part of the robot system for contact purposes (anchor-regime rule).
- **Reachable body region** – a body-region class (§4.3 taxonomy) that the assessed application configuration can physically contact within its declared envelope. Which regions are reachable is a **declared field** (§8.2), corroborated at assessment, not assumed by this Protocol.
- **Not covered** – a state recording that a reachable body region or a declared safeguarding method lacks admissible evidence, so it is excluded from the assessed collaborative envelope rather than assumed compliant.

4 What the evidence must show

4.1 For a collaborative-application envelope, consumed evidence shall demonstrate, for each declared safeguarding method (Clause 6): (a) contact forces (N) and pressures (N/cm²) within the anchor regime's biomechanical limit values for each reachable body region, for the applicable contact type (quasi-static and/or transient); (b) SSM performance where that method is declared; © results at the declared payload and speed-envelope **limits** (kg, m/s), not only at nominal conditions.

4.2 Evidence shall reflect the **application configuration** assessed. Because the tool and workpiece are part of the robot system for contact purposes, bare-arm or bare-flange results shall not support a tooled or loaded application envelope; a change of end-effector, workpiece, or speed limit that raises contact energy shall require re-measurement or an envelope contraction recorded in the assessment record (§8.2). A first-of-model assessment is an ordinary assessment under cold-start parity (VRS-GEN-005 §6).

4.3 Reachable-body-region evidence matrix (target-independent). The body-region taxonomy and the two contact types below are fixed by the anchor regime (ISO 10218-2:2025, ex-ISO/TS 15066:2016) and are therefore target-independent. For each region the assessed application can reach, consumed evidence shall demonstrate compliance with the anchor regime's limit value for that region and contact type. Which regions are reachable is a **declared field** of the application configuration (§4.2), recorded per §8.2 — it is not assumed by this Protocol. Where witnessed live, quasi-static contact per reachable region is VRS-IND-110 step IND-110.08 and transient contact per reachable region is IND-110.09.

BODY-REGION CLASS	CONTACT TYPES TO EVIDENCE	CONSUMED EVIDENCE SHALL DEMONSTRATE
Skull and forehead	Transient only (clamping not permitted)	Peak transient force/pressure within the anchor limit; regions where clamping is possible shall instead be eliminated by design, not rated
Face	Transient only (clamping not permitted)	As above; reachability of the face shall trigger design elimination review, not a measured pass
Neck	Quasi-static and transient	Force (N) and pressure (N/cm ²) within the anchor limit for both contact types
Back and shoulders	Quasi-static and transient	Force/pressure within the anchor limit for both contact types
Chest	Quasi-static and transient	Force/pressure within the anchor limit for both contact types
Abdomen	Quasi-static and transient	Force/pressure within the anchor limit for both contact types
Pelvis	Quasi-static and transient	Force/pressure within the anchor limit for both contact types
Upper arms and elbow joints	Quasi-static and transient	Force/pressure within the anchor limit for both contact types
Lower arms and wrist joints	Quasi-static and transient	Force/pressure within the anchor limit for both contact types
Hands and fingers	Quasi-static and transient	Force/pressure within the anchor limit for both contact types (highest-exposure region in most assembly tasks)
Thighs and knees	Quasi-static and transient	Force/pressure within the anchor limit for both contact types
Lower legs	Quasi-static and transient	Force/pressure within the anchor limit for both contact types

4.4 Where SSM is a declared safeguarding method, separation evidence shall demonstrate the protective separation distance is maintained at the declared operator and robot speeds (m/s), evaluated against the minimum-distance methodology of ISO 13855:2024 and including the stopping contribution of the safety-rated monitored stop function; a validated protective-separation result may reduce the set of reachable body regions requiring PFL contact measurement, and that reduction shall be recorded with its basis (§8.2). Where witnessed live, protective separation distance is VRS-IND-110 step IND-110.10.

4.5 Where the application relies on a safety-related control function to bound speed, force, or separation, evidence shall include the required Performance Level (PL, ISO 13849-1:2023) or SIL (IEC 62061:2021) verification for that function; a PFL or SSM claim whose underlying safety function lacks PL/SIL verification shall not be admissible (Clause 5).

5 Admissible evidence forms

5.1 Contact and separation measurements shall be **instrumented** — measurement-device results against the anchor regime’s method. Demonstration videos, operator or wearer recollection, and marketing claims shall not be admitted as contact or separation evidence.

5.2 Admissible evidence is expressed **by tier**, not by a grade ladder:

- **Documentary (Verified tier).** Accredited-laboratory force/pressure and separation results against ISO 10218-2:2025, third-party reports and certificates, and manufacturer instrumented results witnessed under an audited QMS shall be admissible as documentary evidence and serve the **Verified** rows of the VRS-IND-201 criteria mapped in Clause 6. Manufacturer self-declared instrumented results are admissible as documentary evidence only where corroborated.
- **Witnessed (Certified tier).** Live measurement performed and observed under VRS-IND-110 in a demonstration session shall be the witnessed form; it serves the **Certified** tier of the same criteria. Each witnessed dimension names the VRS-IND-110 step that produces it (Clause 6).

Provenance and consent for either form are recorded per VRS-GEN-012; that reference governs labelling only and assigns no weight or score.

5.3 Evidence measured against a superseded regime (e.g. a standalone ISO/TS 15066:2016 report predating the assessed model’s ISO 10218-2:2025 configuration) shall be admitted only where the measured configuration matches the assessed application configuration; otherwise it shall be treated as not applicable and re-measurement required before it supports a Verified or Certified determination (edition changes trigger review, §8.3).

5.4 Incomplete coverage shall block the collaborative envelope, not degrade it silently: if any reachable body region (§4.3) or declared safeguarding method (Clause 6) lacks admissible evidence, that region or method shall be recorded **not covered** rather than assumed compliant.

6 Safeguarding-method evidence matrix (target-independent)

The safeguarding methods below are fixed by the anchor regime and are therefore target-independent: they state **what** evidence must demonstrate for each method the assessed application declares, regardless of any specific model. The declared application-configuration values that populate them (payload, speed limits, reachable regions, sensing) are a declared field recorded per §8.2. The final column names, for each method, the documentary form that serves the VRS-IND-201 Verified row and the VRS-IND-110 step that witnesses it at Certified.

SAFEGUARDING METHOD (ISO 10218-2:2025)	CONSUMED EVIDENCE SHALL DEMONSTRATE	ANCHOR REFERENCE	DOCUMENTARY (VERIFIED) / WITNESSED (CERTIFIED)
Safety-rated monitored stop	Stop is initiated and maintained on operator presence in the collaborative workspace; stop-function integrity at the required PL/SIL	ISO 10218-2:2025; ISO 13849-1:2023 / IEC 62061:2021	documentary — serves VRS-IND-201 §6.4 Verified row; the protective stop that maintains it, and the presence detection that triggers it, are witnessed under VRS-IND-101 / VRS-IND-110 (detection and safe-stop dimension)
Hand guiding	Guiding-mode enabling, speed limit (m/s), and safe-stop on release, at the required PL/SIL	ISO 10218-2:2025; ISO 13849-1:2023	documentary — serves VRS-IND-201 §6.4 Verified row; where hand guiding is declared, safe-stop-on-release is witnessed within the collaborative demonstration
Speed-and-separation monitoring (SSM)	Protective separation distance maintained at declared speeds (m/s), evaluated against ISO 13855:2024; response to intrusion; PL/SIL of the monitoring function	ISO 10218-2:2025 (SSM); ISO 13855:2024; ISO 13849-1:2023	documentary — serves VRS-IND-201 §6.4 Verified row; witnessed protective separation distance feeds VRS-IND-110 step IND-110.10
Power-and-force-limiting (PFL)	Contact force (N) and pressure (N/cm ²) within the anchor limit for every reachable body region (§4.3), quasi-static and transient, tool and workpiece included, at envelope limits	ISO 10218-2:2025 (ex-ISO/TS 15066:2016 limits)	documentary — serves VRS-IND-201 §6.4 Verified row; witnessed quasi-static contact feeds VRS-IND-110 step IND-110.08 and transient contact feeds IND-110.09

A method the application does not use need not be evidenced only where the envelope excludes it and that exclusion is recorded (§8.2); a method it **declares** shall be evidenced in full per this matrix, or that method's contribution shall be recorded **not covered** (§5.4). Where the declared sensing is optical, degraded-condition behaviour at the declared lighting boundary is witnessed as VRS-IND-110 step IND-110.06 (VRS-IND-201 §6.5); it is outside the contact and separation scope of this Protocol.

7 Worked example (informative)

Example only — not a real product; no robot holds a Veyrum rating. A fictional collaborative palletizing cell declares a **PFL** collaborative application (manipulator class): a robot arm with a vacuum end-effector places 2 kg cartons at a shared station, maximum tool-centre speed 0.25 m/s. The declared reachable

body regions (from the layout) are **hands and fingers, lower arms and wrist joints, and abdomen**; no clamping geometry against fixtures exists (so all three are transient, and hands/fingers and lower arms are additionally quasi-static at the placement nest). Its speed-limiting safety function is declared at PL-d.

Verified (documentary) path. The submission is an accredited-laboratory report against ISO 10218-2:2025 giving measured peak force (N) and pressure (N/cm²) at those three regions, quasi-static and transient, at 0.25 m/s with the 2 kg workpiece attached, all within the anchor regime's limit values; plus an ISO 13849-1:2023 PL-d verification of the speed-limiting function. Every declared region and the PFL method have admissible documentary evidence, so the collaborative envelope is **covered** at the Verified tier: the report serves the Verified row of VRS-IND-201 §6.4 (collaborative operation controls).

Certified (witnessed) path. In a VRS-IND-110 session the same PFL contacts are witnessed at the declared limits: quasi-static contact on a compliant target at each declared region, with the force/pressure reading shown on camera against the anchor limit (IND-110.08), and transient contact at each declared region (IND-110.09). Had SSM been declared instead of PFL, the witnessed protective separation distance (IND-110.10) would serve the same criterion. The witnessed marks serve the Certified tier of VRS-IND-201 §6.4; no arithmetic is performed in this Protocol (VRS-IND-201 and VRS-GEN-005/006 own the determination).

Not-covered contrast. The same submission with **no measurement for the abdomen** region (reachable per the layout) does not lower any result — under §5.4 the abdomen is recorded **not covered**, the collaborative envelope is contracted to exclude tasks that reach the abdomen, and the assessor records the contraction per §8.2. A submission relying on **bare-flange** measurements for a tooled task is inadmissible under §4.2.

8 Consumption and recording

8.1 Documentary evidence serves the Verified row of VRS-IND-201 §6.4 and the safety evidence of the safety_incidents category (VRS-GEN-101); witnessed measurement is recorded as the corresponding VRS-IND-110 steps (IND-110.08–.10) in the Session Record and serves the Certified tier. This Protocol records evidence and its coverage; it assigns no points and computes no rating (VRS-GEN-005/006, VRS-IND-201).

8.2 The assessment record shall identify: the anchor regime edition tested against; the measurement configuration (application, tooling, workpiece, payload in kg, speed limits in m/s); the declared reachable body regions (§4.3) and declared safeguarding methods (Clause 6); the laboratory or witness and the evidence form (documentary or witnessed); the test report or Session Record identifiers and dates (to day precision); whether the assessment is a first-of-model assessment under cold-start parity (VRS-GEN-005 §6); and any envelope contraction applied (§5.4).

8.3 Anchor-regime edition changes (e.g. a future ISO 10218-2 amendment) shall trigger evidence review per VRS-GEN-004 §7; a superseded-edition report shall be re-mapped or re-measured before it supports a Verified or Certified determination.

9 Bibliography

- ISO 10218-1:2025 (iso.org/standard/73933.html; edition 3, 2025-02) — Robotics — Safety requirements — Part 1: Industrial robots.
- ISO 10218-2:2025 (iso.org/standard/73934.html; edition 2, 2025-02) — robot applications and robot cells; TS 15066 absorbed; four collaborative safeguarding methods; explicit cybersecurity requirements.
- ISO/TS 15066:2016 (iso.org/standard/62996.html) — historic collaborative supplement; source of the per-body-region quasi-static/transient biomechanical force and pressure limits.
- ISO 13855:2024 (iso.org/standard/80590.html; edition 3, 2024-11) — Safety of machinery — Positioning of safeguards with respect to the approach of the human body. Supersedes ISO 13855:2010 (now withdrawn).
- ISO 13849-1:2023 (iso.org/standard/73481.html; edition 4, 2023-04) — safety-related parts of control systems, Performance Level.
- IEC 62061:2021 (webstore.iec.ch/en/publication/59927; edition 2) — functional safety of safety-related control systems, SIL.

10 Change history

DATE	VERSION	STATUS	CHANGE	AUTHORITY
2026-09-16	1.0.0	Draft	VRS 2026 rewrite: recast as the collaborative-application contact/separation method and apparatus reference for VRS-IND-110. Test methods, apparatus, anchor regimes, the safeguarding-method matrix and the body-region taxonomy kept. Evidence now expressed by tier (documentary → VRS-IND-201 §6.4 Verified row; witnessed → VRS-IND-110 Certified steps) with the §5.2 grade ladder removed; scoring language (points, sub-scores, “informs ... scoring”, “C1”, op-hours exposure denominator, null-vs-zero inputs) removed. Application classes aligned to VRS-IND-201 §7.3 (mobile · manipulator · legged-other); former collaborative-application/fixed-cell → manipulator, stated once in the Foreword. Witnessed PFL contact now names its VRS-IND-110 steps (quasi-static IND-110.08, transient IND-110.09) and SSM separation names IND-110.10; ISO 13855:2024 added as the separation-distance methodology anchor. VRS-GEN-201 and cold-start-margin references removed; first-of-model recast as an ordinary assessment under cold-start parity (VRS-GEN-005 §6). Removed the word “provisional”. No constant/weight/band changed (TP holds none; no -501 twin). See GEN-005 §6.	Curator; VRS 2026 rewrite Batch D
2026-09-12	0.2.0	Draft	DEEPEN: brought to publishable depth on the IND-101 shell pattern — added anchor references (ISO 10218-1/-2:2025, ISO/TS 15066:2016, ISO 13849-1:2023, IEC 62061:2021, all verified this run); resolved the former §4.3 PENDING-TARGET reservation by distinguishing the anchor-derived, target-independent body-region taxonomy matrix (retained) from per-target reachability (now a declared field) — no robot data invented; added SSM/PL-SIL evidence rules (§4.4–4.5), explicit admissibility ladder + not-covered blocking gate (Clause 5), safeguarding-method evidence matrix (Clause 6), worked example (Clause 7). No constant/weight/band changed (TP holds none; no -501 twin). Net words 404→2,099; shall 7→28.	Curator Run #49; charter DEEPEN
2026-09-05	0.1.0	Draft	Evidence-consumption shell; body-region matrix reserved; instrumented-only rule	CEO 2026-09-05

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